

*The preservice teacher
knows the discipline...*

Mathematics Education

(Grades 1 - 12)

Introduction

The following competencies are intended to clarify Standard 1.1, “. . . knows the discipline,” in the N-STEP process. The competencies are firmly rooted in the profession’s best knowledge and practices. These competencies are drawn from guidelines established by the Mathematical Association of America and National Council of Teachers of Mathematics. The competencies are broadly stated with the intent that teacher preparation institutions will determine the breadth and depth of material for meeting the competencies. The statements represent the minimum expected of beginning teachers in order to be licensed to teach.

The mathematical process and tools competencies are extremely important for all teachers. We have listed them separately, as we envision that teachers of mathematics will be conversant with these skills across the content specified in the other standards. Competencies addressing facility with technology tools important for teachers of mathematics have been included within this strand. We view these competencies as unique to the discipline of mathematics and, therefore, feel strongly they should be included here.

Many of the competencies are prescribed for all teachers of mathematics, though it is expected that each institution will clearly delineate the breadth and depth of the student knowledge at each certification level. For example, the Number Operation strand includes the study and exploration of natural numbers. In this case, elementary teachers must be able to demonstrate thorough knowledge and understanding of the properties and relationships of naturals, wholes, integers, and rational numbers as well as their relationship to the real numbers. However, their knowledge of complex numbers, beyond knowing they exist, may be far more limited. On the other hand, middle and secondary teachers must have knowledge of all of the above and be able to use the various systems to analyze data, solve problems, and describe the very nature of mathematics through the number systems.

The beginning (preservice) mathematics teacher will demonstrate a knowledge of and/or competency in the following areas of study:

For the teacher of:	Grades 1-6	Grades 5-9	Grades 9-12
1. Mathematical Processes and Tools CR 1-4, a-h	1. Use problem solving to investigate and understand mathematical content; (G 1.2, 3.5-6; NCTM P1.1.1, M1.1.1, S1.1.1; MAA I.2)		
	2. Communicate mathematical ideas in writing and orally, using mathematical language and symbols; (G 2.1, 4.1; NCTM P1.2.1, M1.2.1, S1.2.1; MAA I.2, I.3)		
	3. Develop and evaluate mathematical conjectures and arguments to explain and validate mathematical reasoning; (NCTM P1.3, M1.3, S1.3; MAA I.1, IV.2, IV.7)		
	4. Use mathematical modeling to simulate events and occurrences; (G 1.8, 3.2; NCTM M1.5, S1.5.4, S1.5.11; MAA I.4)		
	5. Analyze and articulate connections within mathematics; (G 1.6; NCTM P1.4.2, M1.4.2, S1.4.2; MAA I.6)		
	6. Analyze and articulate connections of mathematics to other disciplines through applications; (G 2.4; NCTM P1.4.2, M1.4.2, S1.4.2; MAA I.2)		
	7. Understand the historical development of mathematics including the contributions of underrepresented groups and diverse cultures; (G 2.3, 2.4; NCTM P1.7, M1.8, S1.7; MAA I.6, III.2, IV.1, IV.2)		
	8. Use manipulatives to model and explain mathematical concepts; (G 1.4, 4.1; NCTM S1.5.11, S2.3)		
	9. Articulate the dynamic nature of mathematics and its significant role in social, cultural, and economic development; (G 1.6, 1.10, 4.1; NCTM S1.4.1; MAA I.3, I.6)		
	10. Use calculators and computers as tools to generate multiple representations of mathematical concepts; (MAA I.5)		

The Mathematics Education competencies have been developed to correlate with the following documents:

- Missouri's Show-Me Standards abbreviated as:
M 1.4 = Mathematics section, statements 1 and 4
G 1.4 = Goal 1, statement 4
- Missouri's minimum requirements for Mathematics Education certification, effective September 1, 1997 abbreviated as:
CR 2, b = Certification Requirement number 2 and item b "Structure of the Real Number System"
- National Council of Teachers of Mathematics (NCTM) guidelines for primary (K-4), middle school (5-8), and secondary (7-12) teachers as reprinted in the National Council for the Accreditation of Teacher Education Approved Curriculum Guidelines abbreviated as:
NCTM P1.1.2 = NCTM K-4 Standard 1.1.2
NCTM S1.5.2 = NCTM grades 7-12 Standard 1.5.2
- Mathematical Association of America (MAA) guidelines as printed in "A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics," Mathematical Association of America (MAA) Committee on the Mathematical Education of Teachers, James R. C. Leitzel, editor, 1991. abbreviated as:
MAA I.2 = Standard I.2

Beginning Teacher Discipline-Specific Competencies: Mathematics Education

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For the teacher of:	<u>Grades 1-6</u>	<u>Grades 5-9</u>	<u>Grades 9-12</u>
Mathematical Processes and Tools <i>(continued)</i>	11. Demonstrate facility with technological tools to support geometric construction/investigation, graphing, pattern exploration, and data investigation; (G 2.7; NCTM P2.3, M2.2, S2.2; MAA I.5)	12. Demonstrate facility with technological tools to support geometric construction/investigation, graphing, matrix exploration, and data investigation; and (G 2.7; NCTM P2.3, M2.2, S2.2; MAA I.5)	
	13. Understand and articulate the role of technology in supporting the development of mathematical understanding. (G 1.4; NCTM P1.6.1, P1.6.2, M1.7.1, M1.7.2, S1.6.1, S1.6.2)		
2. Number Operation CR 1 2, b, c	1. Understand properties of real numbers, including equivalent representations of numbers; (M.1; NCTM P2.2.2, M1.6.1, S1.5.1; MAA II.1, III.1)	2. Understand properties of real and complex numbers, including equivalent representations of numbers; (M.1, 5; NCTM P2.2.2, M1.6.1, S1.5.1; MAA II.1, III.1, IV.1)	
	3. Analyze the effect of and relationships among operations on real numbers; (M.1; NCTM P1.5.1, P1.5.4; MAA II.1)	4. Analyze the effect of and relationships among operations on real and complex numbers; (M.1; NCTM P1.5.4; MAA II.1)	
	5. Use estimation in working with quantities, measurement, computation, and problem solving; (M.1; NCTM P1.5.10; MAA II.1)		
	6. Develop, use, model, and explain computational algorithms; and (M.1; NCTM P1.5.2, M2.2.3, S1.5.2; MAA II.1)		
	7. Understand and apply numerical computation techniques (mental, paper/pencil, calculator) and extend them to algebraic expressions. (M.1; NCTM P1.5.3, M1.6.2, S1.5.2; MAA II.1)		

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For the teacher of:	<u>Grades 1-6</u>	<u>Grades 5-9</u>	<u>Grades 9-12</u>
3. Geometry and Measurement CR 3	1. Understand and apply various systems and tools of measurement; (M.2; NCTM P1.5.5, M1.6.3, S1.5.3)		
	2. Understand and apply Euclidean geometric concepts, properties, and relationships to describe and model mathematical ideas in real-world constructs; (M.2; NCTM P1.5.6, M1.6.4, S1.5.4; MAA III.2)		
	3. Identify, describe, measure, compare, classify, and represent two- and three-dimensional geometric figures; (M.2; MAA II.2)		
	n/a	4. Understand and apply trigonometric concepts, properties, and relationships; (M.2; MAA III.2)	
	5. Understand and apply concepts of motion in two-dimensional space through transformations; (M.2; MAA III.2)	6. Understand and apply concepts of motion in two- and three-dimensional space through transformations; and (M.2; MAA III.2)	
	n/a	7. Perform geometric constructions using straight-edge and compass and prove that the constructions yield the desired result. (M.2; NCTM M1.6.4, P1.5.4; MAA II.2)	
4. Data Analysis, Probability, and Statistics CR e	1. Collect, organize, and display data in meaningful form(s); (M.3, 1.8, 2.1; NCTM P1.5.7, M1.6.5, S1.5.5; MAA II.4, III.4, IV.4)		
	2. Use experimental and theoretical probabilities as appropriate to formulate and solve problems involving uncertainty; (M.3, 2.1; NCTM P1.5.8, M1.6.5, S1.5.6; MAA II.4, III.4, IV.4)		
	3. Use descriptive statistics (e.g. measures of central tendency and dispersion) to analyze data and to make predictions and decisions; and (M.3, 3.5; NCTM P1.5.8; MAA II.4)	4. Use descriptive statistics (e.g. measures of central tendency and dispersion) and inferential statistics (e.g. hypothesis testing) to analyze data and to make predictions and decisions. (M.3, 3.5; NCTM M1.6.5, S1.5.5; MAA III.4, IV.4)	

The beginning (preservice) mathematics teacher will demonstrate a knowledge of and/or competency in the following areas of study:

5. Patterns, Functions, and Relationships CR 1-4, a-h	1. Identify and describe patterns and relations; (M.4, 1.6; NCTM P1.3; MAA II.3)	
	2. Represent patterns and functions as symbolic expressions, verbal descriptions, tables and graphs, and move from one representation to another; (M.4, 1.6, 2.2, 3.4; NCTM P1.5.9, M1.6.6, S1.5.7; MAA I.3, II.3, IV.3, III.3)	
	3. Discover and analyze functional relations which arise from diverse problem situations; (NCTM E1.4.1)	
	4. Use algebraic concepts and notation to describe relationships and solve problems; (M.4; MAA II.3)	
	n/a	5. Use basic trigonometric relations including the graphic representation and real-world application; and (M 4)
	n/a	6. Use trigonometric equations and inequalities to solve problems. (M 4)
6. Mathematical Systems CR 2, 3, h	n/a	1. Construct logical proofs to validate or refute mathematical conjectures; (M 4)
	n/a	2. Understand the nature and purpose of axiomatic systems; and (M.5; NCTM M1.6.7, S1.5.8)
	n/a	3. Understand and apply the major concepts of linear and abstract algebra. (M.5; NCTM S1.5.8; MAA III.3)
7. Discrete Mathematics CR 1-4, b, d-f	1. Use a variety of counting techniques and principles, such as permutations and combinations; (M.6; NCTM S1.5.10; MAA IV.6)	
	2. Identify, model, and analyze situations represented by discrete and continuous data; (M6; NCTM P, M, S1.5.10)	
	n/a	3. Represent problem situations using discrete structures such as sets, finite graphs, matrices, sequences, and recurrence relations; (M.6; NCTM S1.5.10; MAA IV.6)

The beginning (preservice) mathematics teacher will demonstrate a knowledge of and/or competency in the following areas of study:

Discrete Mathematics (continued)	n/a		4. Understand and use algorithmic and recursive techniques in solving problems; and (M.6; NCTM M1.6.9; MAA IV.6)
	-n/a		5. (Represent and solve problems using linear programming and difference equations. (M.6; NCTM S1.5.10; MAA IV.6)
8. Concepts of Calculus CR 1, d	n/a	1. Understand and apply basic calculus concepts and techniques (e.g. evaluation of limits) to solve a variety of applied problems; (NCTM M1.6.1; S1.5.1; MAA III.1)	2. Understand and apply the concepts of limit, continuity, differentiation, integration, and other continuous processes; (G 2.2; NCTM S1.5.9; MAA IV.3, IV.5)
	n/a		3. Use properties and techniques of calculus to model two- and three-dimensional phenomena; and (G 2.2; NCTM S1.5.9; MAA IV.5)
	n/a		4. Understand and apply infinite sequences, infinite series, and power series. (NCTM S1.5.1; MAA III.1)